REMARKS

Reconsideration of the patent application in view of the preceding amendments and the following remarks is respectfully requested. Applicants gratefully acknowledge the Examiner's finding of allowable subject matter within the previously presented claims. Upon entry of this Amendment, claims 27, 36-38, 40, 43, 46 and 47 will stand amended, claims 28, 31-35, 39, 42, 44, 45, and 48-52 will be cancelled, and claims 53-62 will be newly added.

I. Rejection of the Claims Under 35 U.S.C. § 102

In the office action dated February 7, 2003, the Examiner rejected claims 27-29, 31-33, and 39-42 under 35 U.S.C. § 102. The Examiner stated that the claimed invention was anticipated by Vannelli, "An adaptation of the interior point method for solving the global routing problem." Although Applicants disagree with the Examiner's finding of anticipation, Applicants have presented the following amendments and cancellations of the subject claims in this Amendment to expedite prosecution: 1) claim 27 has been amended to incorporate the limitations of claim 35; claims 28, 31(as originally filed, see below), 32, 33, 39 and 42 have been cancelled; and, claim 40 has been amended such that it and claim 41 indirectly depend from amended claim 27. These amendments and cancellations obviate the 35 U.S.C. §102 rejection of the subject claims. As to claim 31—now rewritten as claim 53 with limitations similar to amended claim 27—however, Applicants respectfully traverse the Examiner's rejection.

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II. Rewritten Claim 31 (*i.e.*, Claim 53) Is Novel and Nonobvious

A. Vanelli Discusses Rectilinear Routing

In his description of routing, Vanelli only discusses *rectilinear* routing. This is shown through reference to at least two different sections of his publication:

> "There are many ways to connect a net in the global routing problem; each way is a rectilinear spanning tree connecting the given pins of the net." *P. 194, Col. 1, lines 26-28.*

> "One can reduce the initial size of the columns in (ROUTING) by selecting only the minimal rectilinear Steiner trees or near minimal rectilinear Steiner trees." *P. 195, Col. 1, lines 12-14.*

By suggesting that his method is applicable to rectilinear routing, Vanelli certainly does not teach, or even suggest, that his methods are applicable to a method of routing nets that includes partitioning the design region into a first set of sub-regions, wherein a plurality of paths exist between the sub-regions, and wherein a plurality of the paths are *diagonal* paths.

B. Vanelli's Grid Graphs only Depict Rectilinear Routing

In his depictions of routing, Vanelli only depicts rectilinear routing. This is shown in reference to Figs. 1, 3, 6 and 7. This is more support for the fact that he does not represent anything regarding diagonal routing.

C. Vanelli's Use of "Diagonal" Is with Regard to a Diagonal Matrix

Vanelli's only mention of the term "diagonal" is in reference to solving a mathematical equation using a diagonal matrix:

> The key bottleneck step in all interior point methods is the determination of the projection direction. This is obtained by solving a system of symmetric linear equations where
>
> $$(A^T D^2_k A)dx = c$$
>
> where D is a *diagonal* m x m matrix and d_i is the inverse of the slack for constraint I at iteration k. *P. 196, Col. 2, lines 24-28, emphasis added.*

Reporting that one can solve an equation with a diagonal matrix suggests nothing about a method of routing nets that includes partitioning the design region into a first set of sub-regions, wherein a plurality of paths exist between the sub-regions, and wherein a plurality of the paths are *diagonal* paths.

D. Rewritten Claim 31 (*i.e.*, Claim 53) Contains Similar Limitations to that of Allowable, Amended Claim 27.

In the Office Action dated February 7, 2003, the Examiner stated that, if rewritten in independent form, claim 35 would be allowable. Applicants have accordingly amended claim 27 to contain all the limitations of previous claim 35. Applicants respectfully invite the Examiner to perform a line-by-line comparison of allowable amended claim 27 with newly added claim 53. Such a comparison is presented below:

> 27—A method of routing nets within a particular region of a design layout, each net having a set of pins, the method comprising:
>
> 53—A method of routing nets within a particular region of a design layout, each net having a set of pins, the method comprising:

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27(a)—partitioning the design region into a first set of sub-regions, wherein a plurality of inter-sub-region edges exist between the sub-regions, and wherein a plurality of the inter-sub-region edges are diagonal

53(a)—partitioning the design region into a first set of sub-regions, wherein a plurality of paths exist between the sub-regions, and wherein a plurality of the paths are diagonal paths

27(b)—for each particular net, identifying a set of routes, wherein each route in the route set identified for a particular net traverses a set of sub-regions containing the particular net's pins, wherein each route includes a set of route edges, and each route connects two sub-regions, and wherein routes are defined with respect to inter-sub-region edges

53(b)—for each particular net, identifying a set of routes, wherein each route in the route set identified for a particular net traverses a set of sub-regions containing the particular net's pins, wherein each route includes a set of route edges, and each route edge connects two sub-regions, and wherein the routes are defined with respect to the paths between the sub-regions

27(c)—formulating a linear-programming ("LP") problem based on the identified routes, wherein formulating an LP problem includes using the identified routes to specify an objective function to optimize

53(c)—formulating a linear-programming ("LP") problem based on the identified routes, wherein formulating an LP problem includes using the identified routes to specify an objective function to optimize

27(d)—solving the LP problem to identify one route for each net

53(d)—solving the LP problem to identify one route for each net

As one can see, amended claim 27 and newly added claim 53 are very similar. The one real difference between them is that claim 27 refers to "inter-sub-region edges," while claim 53 refers to "paths that exist between sub-regions." These terms, while different, convey related concepts. This is best seen in reference to sections of Applicants' application, which are described below.

Figure 10, as described on page 20, lines 8-18, depicts inter-sub-region edges:

> As shown in **Figure 10**, the grid 905 defines 12 vertical edges (E0-E11) and 12 horizontal edges (E12-E23), while the grid 910 defines 9 -45° edges (E24, E26, E28, E30, E32, E34, E36, E38, E40) and 9 +45° edges (E25, E27, E29, E31, E33, E35, E37, E39, E41). In **Figure 10**, the diagonal edges are shown to have endpoints, in order to simplify the identification of these edges as they abut each other.
>
> As shown in **Figure 10**, each diagonal edge traverses the distance between the centers of two sub-regions that are defined by the first grid and that are at diagonally adjacent positions with respect to each other. In other words, each diagonal edge connects the centers of two sub-regions that are aligned diagonally such that they abut at only one of their corners.

These inter-sub-region edges are typically used to define routing paths:

> In some embodiments, grids 905 and 910 are also used to define routing paths between the child slots of a partitioned region. Specifically, orthogonal to each edge defined by grids 905 and 910 is a routing path that can be used by a routing tree to connect the abutting slots (*i.e.*, the abutting sub-regions). For instance, Figure 12 illustrates 42 wiring paths across the 42 edges of Figure 10. Horizontal paths P0-P11 are defined across vertical edges E0-E11, vertical paths P12-P23 are defined across horizontal edges E12-E23 . . . . *Page 20 line 19 to page 21 line 4.*

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In other words, the inter-sub-region edges recited in amended claim 27 are used to define the paths existing between sub-regions in newly added claim 53.

Respectfully, Applicants contend that since a method of routing nets involving a plurality of inter-sub-region edges is patentable, a method of routing nets involving a plurality of paths defined from the edges is also patentable. Accordingly, the Examiner's rejection under 35 U.S.C. § 102 should be withdrawn.

II. Rejection of the Claims Under 35 U.S.C. § 103(a)

In the office action dated February 7, 2003 the Examiner rejected claims 43-47 and 30 under 35 U.S.C. § 103(a). The Examiner stated that claims 43-47 were unpatentable over Vannelli and that claim 30 was unpatentable over Vannelli in view of Theune, "HERO: hierarchical EMC-constrained routing." Although Applicants disagree with the Examiner's finding of obviousness, Applicants have presented the following amendments and cancellations of the subject claims in this Amendment to expedite prosecution: 1) claim 43 has been amended to include the limitations of claim 35; 2) claims 44 and 45 have been cancelled; 3) claims 46 and 47 have been amended to depend from amended claim 43; and, 4) claim 30 has been cancelled. These amendments and cancellations obviate the 35 U.S.C. §103 rejection of the subject claims.

III. Claim Objections

In the office action dated February 7, 2003 the Examiner objected to claims 34-38 and 48-49 as being dependent upon a rejected base claim. The Examiner stated that the claims would be allowable if rewritten in independent form including all of the

limitations of the base claim and any intervening claims. Applicants have accordingly amended claim 27 to have all the limitations of claim 35, and claims 36-38, 40, and 41 depend from that claim. Claim 43 has been amended to contain all the limitations of claim 48, and claims 46 and 47 depend from it. Applicants have rewritten claim 49 as newly added claim 59, and have added dependent claims 60-62. Respectfully, therefore, claims 27, 36-38, 40, 41, 43, 46, 47, and 59-62 are in condition for allowance.

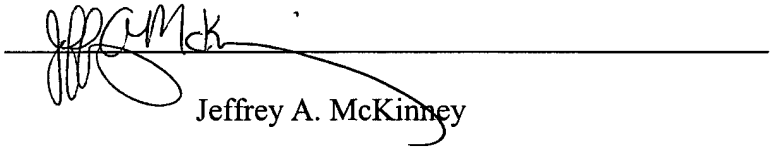
CONCLUSION

In view of the foregoing, it is submitted that the claims are in condition for allowance. Reconsideration of the rejections and objections is requested. Allowance is earnestly solicited at the earliest possible date.

Respectfully submitted,

STATTLER, JOHANSEN & ADELI LLP

Dated: 7-7-03



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THE AMENDED CLAIMS

The following pages provide the amended claims with the amendments marked with deleted material in [brackets] and new material underlined to show the changes made.

27. (Currently Amended) A method of routing nets within a particular region of a design layout, each net having a set of pins, the method comprising:

a) partitioning the design region into a first set of sub-regions, wherein a plurality of inter-sub-region edges exist between the sub-regions, and wherein a plurality of the inter-sub-region edges are diagonal;

b) for each particular net, identifying a set of routes, wherein each route in the route set identified for a particular net traverses a set of sub-regions containing the particular net's pins, wherein each route includes a set of route edges, and each route edge connects two sub-regions, and wherein routes are defined with respect to the inter-sub-region edges;

c) formulating a linear-programming ("LP") problem based on the identified routes, wherein formulating an LP problem includes using the identified routes to specify an objective function to optimize; and

d) solving the LP problem to identify one route for each net.

Cancel claim 28.

29. (Currently Amended) The method of claim [28] 27, wherein the objective function includes a component for overall length of the routes for the nets, and solving

the LP problem includes searching for a solution to the objective function that reduces the overall-length component.

30. (Currently Amended) The method of claim [28] 27, wherein the objective function includes a component for the expected number of vias for the routes for the nets, and solving the LP problem includes searching for a solution to the objective function that minimizes the via-number component.

Cancel claims 31-35.

36. (Currently Amended) The method of claim [35] 27, wherein

the objective function includes a congestion-component that quantifies the congestion of the inter-sub-region edges, and

solving the LP problem includes:

measuring the congestion of the inter-sub-region edges for each solution considered by the objective function;

identifying a solution that reduces the congestion of the inter-sub-region edges.

37. (Currently Amended) The method of claim [35] 27, wherein formulating an LP problem includes specifying [a] at least one congestion constraint regarding the congestion of the inter-sub-region edges between the sub-regions.

38. (Currently Amended) The method of claim [35] 27, wherein some of the inter-sub-region edges share common regions with other inter-sub-region edges, wherein

formulating an LP problem includes specifying that the capacity of the common regions be properly shared among the inter-sub-region edges.

Cancel Claim 39.

40. (Currently Amended) The method of claim [39] 38, wherein specifying at least one constraint includes requiring that only one route be selected for each net.

Cancel Claim 42.

43. (Currently Amended) A computer readable medium comprising a computer program having executable code, the computer program for routing a net within a particular region of a design layout, the net having a plurality of pins, the computer program comprising:

a) a first set of instructions for partitioning the design region into a first set of sub-regions, wherein a plurality of paths exist between the sub-regions, and wherein a plurality of the paths are diagonal paths, and wherein some of the paths share common regions with other paths;

b) a second set of instructions for identifying, for each particular net, a set of routes, wherein each route in the route set identified for a particular net traverses a set of sub-regions containing the particular net's pins, wherein each route includes a set of route edges, and each route edge connects two sub-regions, and wherein the routes are defined with respect to the paths between sub-regions;

c) a third set of instructions formulating a linear-programming ("LP") problem based on the identified routes, wherein the third set of instructions includes a

fifth set of instructions for using the identified routes to specify an objective function to optimize, and wherein the third set of instructions further includes a sixth set of instructions for specifying that the capacity of common regions be properly shared among paths; and

d) a fourth set of instructions solving the LP problem to identify one route for each net.

Cancel claims 44-45.

46. (Currently Amended) The computer readable medium of claim [45] 43, wherein

the objective function includes a congestion-component that quantifies the congestion of the paths, and

the fourth set of functions includes:

a [sixth] seventh set of instructions for measuring the congestion of the paths for each solution considered by the objective function;

[a seventh] an eighth set of instructions for identifying a solution that reduces the congestion of the paths.

47. (Currently Amended) The computer readable medium of claim [45] 43, wherein the third set of instructions further includes a [sixth] seventh set of instructions for specifying a congestion constraint regarding the congestion of the paths between the sub-regions.

Cancel claims 48-52.